THE U.S. NAVY'S TRANSITION TO JETS

Robert C. Rubel

Definition of an optimist: a naval aviator with a savings account.
QUIP POPULAR IN NAVAL AVIATION

As we approach 2011, the centennial year of aviation in the U.S. Navy, the jet engine and jet-powered aircraft have become ubiquitous. Today millions travel safely in jet airliners, and the military jet fighter is almost a cultural icon. However, in the late 1930s the prospect for powering aircraft with anything but piston engines seemed remote, except to a few visionary engineers in Great Britain and Germany. In the early 1940s their work resulted in the first flights of jet-powered aircraft, but due to the low thrust of their engines these aircraft were outclassed by existing piston-engine fighters. Additional advances in engine design in Germany resulted in the fielding of the Me-262 Swallow fighter, which, although not as maneuverable as the American P-51 Mustang or other Allied fighters, had a top speed 100 mph faster, due to its jet engines and swept wings, giving it significant operational advantages. After the war, aeronautical engineers from all the Allied nations studied German technical advances and worked to incorporate them into their new generations of fighters.

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Naval War College Review, Spring 2010, Vol. 63, No. 2

When the U.S. Navy introduced its first operational jet, the McDonnell F1H Phantom, in 1947, it began a transition phase that turned out to be extended and very costly in terms of aircrew lives and airplanes lost. The higher speeds and altitudes of jets presented a new set of problems to the aircraft designers and manufacturers, as well as to the Navy squadrons that operated them. In 1946, nobody knew that a high-performance jet fighter needed such appurtenances as a stabilator (instead of an elevator); irreversible,

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
2010		**00-00-2010 to 00-00-2010**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
The U.S. Navy's Transition to Jets	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Naval War College,686 Cushing Road,Newport,RI,02841-1207**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

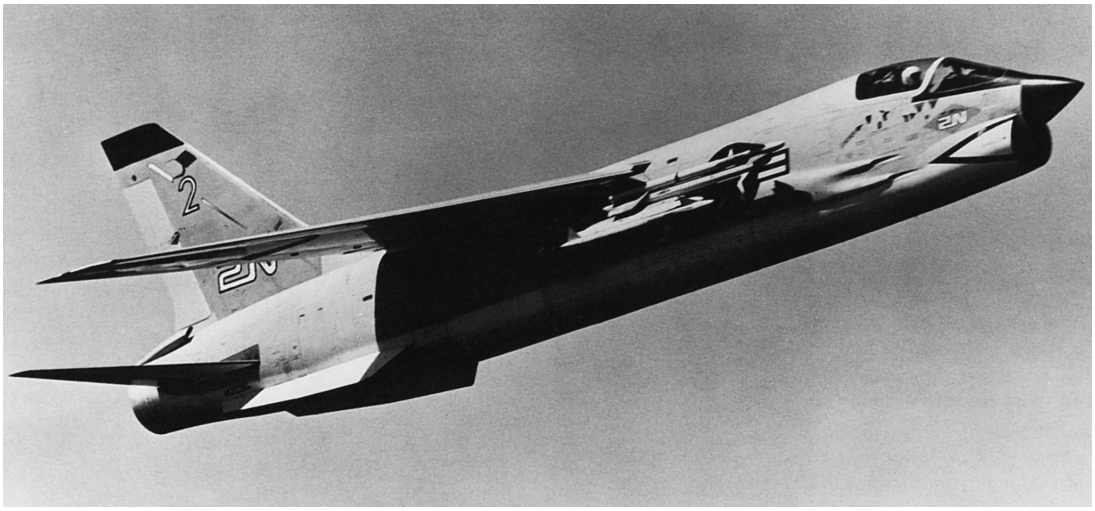
12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**11**	



F8U-2N Crusader

U.S. Navy

hydraulic flight controls with artificial feel; redundant hydraulic systems; pitch and yaw stability augmentation; ejection seats; air conditioning; and others.[1] Learning these lessons required a trial-and-error process that resulted in the fielding and rapid obsolescence of a series of different jets, each reflecting solutions to the defects discovered in earlier models.

It is central to the story presented in this article to consider how long this "transition" to jets lasted. Some histories of naval aviation regard the transition to jets to be substantially complete with the phasing out of the last propeller-driven fighter, the F4U Corsair, while others maintain that the transition lasted until the introduction of the F-8 Crusader and F-4 Phantom II—the first Navy carrier-based fighters that were the equals of their land-based counterparts. Another way of looking at it is through the lens of safety: one might declare the transition to have been complete when the Navy aviation accident rate became comparable to that of the U.S. Air Force. The logic behind this reasoning is that whereas a multitude of factors—technical, organizational, and cultural—constitute the capability to operate swept-wing jets, the mishap rate offers an overall indicator of how successful an organization is in adopting a new technology. Using this criterion, the Navy's transition process lasted until the late 1980s—which was, not coincidentally, the era in which the F/A-18 arrived in the fleet in numbers. This article argues that tactical jet aircraft design and technology presented Navy aircrews, maintenance personnel, and leaders with several major challenges that were in fact not substantially overcome until the introduction of the F/A-18 Hornet in 1983. These challenges included such technical problems as engine reliability and response times, swept-wing flight

characteristics, and man/machine interface issues. The Air Force also encountered these challenges, but the Navy's operating environment and, indeed, its organizational culture kept it from achieving a fully successful transition until well after the Air Force did.

Between 1949, the year jets started showing up in the fleet in numbers, and 1988, the year their combined mishap rate finally got down to Air Force levels, the Navy and Marine Corps lost almost twelve thousand airplanes of all types (helicopters, trainers, and patrol planes, in addition to jets) and over 8,500 aircrew, in no small part as a result of these issues. Perhaps the statistics for the F-8 Crusader, a supersonic fighter designed by Vought in the late 1950s, provide a good illustration of the problem. The F-8 was always known as a difficult airplane to master. In all, 1,261 Crusaders were built. By the time it was withdrawn from the fleet, 1,106 had been involved in mishaps. Only a handful of them were lost to enemy fire in Vietnam.[2] While the F-8 statistics might have been worse than those for most other models, they make the magnitude of the problem clear: whether from engine failure, pilot error, weather, or bad luck, the vast majority (88 percent!) of Crusaders ever built ended up as smoking holes in the ground, splashes in the water, or fireballs hurtling across a flight deck. This was naval aviation from 1947 through about 1988. Today, the accident rate is normally one or less per hundred thousand hours of flight time, making mishaps an

F/A-18 Hornet

U.S. Navy

unusual occurrence. This is in stark contrast to the landmark year of 1954, when naval aviation (that is, Navy and Marine combined) lost 776 aircraft and 535 crew, for an accident rate well above fifty per hundred thousand flight hours—and the rate for carrier-based tactical aviation was much higher than that.

During this extended transition period, naval aviation participated in three major wars and numerous crises, and, of course, many planes and crews were lost to enemy fire. However, the vast majority of aircraft losses over this period were due to mishaps, many of which were associated with the technical and organizational problems just mentioned. In other words, the airplanes that populated the flight decks of aircraft carriers from the introduction of the F1H Phantom through the retirement of the F-14 Tomcat were, with few exceptions, hard to fly and maintain and would kill the unwary crew. Many men and a few women gave their lives trying to operate these machines in the challenging environment of the sea. This history is meant to recognize their sacrifice and honor their service.

THE OPERATIONAL IMPERATIVE

U.S. naval aviation ended World War II at the pinnacle of success; its propeller-driven aircraft were the best in the world, and the requirements of carrier suitability did not compromise their performance versus that of land-based fighters. By the early 1940s the Navy's Bureau of Aeronautics had received word of jet engine developments in Germany and Great Britain and had commissioned Westinghouse and Allis Chalmers to build American versions. However, the high fuel consumption, low power at takeoff, and poor reliability of early engines did not make them attractive for use in carrier-borne planes. Moreover, when details of German aerodynamic advances, specifically the swept wing, became known, Navy planners felt that high landing speeds and adverse handling characteristics would make aircraft equipped with them unsuitable for carrier use.

On the other hand, the Navy was faced with a new opponent, the Soviet Union, that had also capitalized on captured German knowledge. If the Soviets were to build a high-speed jet bomber, carriers might be defenseless if they could not launch high-speed interceptors from their decks. As the Cold War came into being, this knowledge pressurized the development of jet aircraft, adding to the rapidity with which it took place but also imposing brutal material and human costs.

An additional source of pressure was the new U.S. Air Force, whose leadership in the postwar environment believed that the combination of the atomic bomb and the ultra-long-range bomber rendered naval aviation irrelevant. The Navy had long regarded strikes against land targets to be a fundamental mission of its

own air arm, and the prospect of being sidelined in the business of nuclear attack seemed to threaten the very existence of naval aviation. In April 1949 the secretary of defense, Louis Johnson, canceled the construction of USS *United States,* a very large aircraft carrier that had been designed to support a new generation of big Navy jet bombers capable of carrying the large and heavy nuclear weapons of the day. This cancellation, along with Air Force efforts to push the huge B-36 bomber program at the expense of the other services, produced in October 1949 an incident that has been termed the "Revolt of the Admirals." Admiral Arthur Radford and other aviation flag officers, as well as the Chief of Naval Operations (CNO), Admiral Louis Denfeld, testified before Congress arguing the need for an atomic delivery capability for naval aviation and alleging the deficiencies of the B-36—in direct contravention of the secretary of defense's wishes. Although Admiral Denfeld was subsequently fired by the secretary, Congress was sufficiently convinced of the Navy's utility in strike warfare to authorize in 1951 the construction of USS *Forrestal,* the first of the "supercarriers" that could adequately handle the heavy, fast jets. However, the Navy still needed a jet to perform the mission of nuclear strike, and development pressures continued.

The early Cold War operational environment was challenging for naval aviation, to say the least. Knowing that the Soviet Union was working on jet fighters and jet bombers that could carry nuclear weapons and drop them on naval formations, the Navy needed to develop fighter/interceptor aircraft that could defend the carrier and its escorts from attack while sailing into position to launch its own strike, and also strike aircraft that had enough range to hit meaningful targets and enough speed to survive enemy defenses. These general requirements propelled naval aviation development efforts from the late 1940s through the 1970s. During this period, the actual employment of naval aviation in two wars—Korea and Vietnam, as well as later in DESERT STORM—demanded of Navy jets the flexibility to conduct conventional bomb delivery, close air support, and dogfighting. Thus carrier jets morphed over time to designs that were more general in purpose, resulting ultimately in the F/A-18 Hornet, an aircraft that is a true strike-fighter.

Thus there was no opportunity for naval aviation to rest on its laurels after World War II. In combination with a massive postwar demobilization, it had to forge ahead with a program to adopt the new engine and aerodynamic technology. It attempted to reduce strategic risk, by letting multiple contracts to different aircraft companies in hopes that at least one of the designs would be viable. On the other hand, it accepted a high degree of operational risk, by ordering series production of various models before flight-testing was complete. The net

effect of this strategy was that between 1945 and 1959 twenty-two Navy fighters made their first flights, whereas over the following forty-six years only five did so.[3] Some of the designs spawned during the early period, such as the F2H Banshee, were useful machines and had lengthy service lives, while others, like the F7U Cutlass and F-11 Tiger, were disappointments and saw only brief service.

As mentioned previously, the first years of the jet era in the Navy were disastrous in terms of aircraft and crews lost, but the Navy had little choice but to continue sending jets to sea. The gas-guzzling nature of jets made getting them back aboard the carrier in a timely manner a matter of utmost urgency and increased the pressure on carrier captains, admirals, and their staffs to adapt to an operational tempo very different from what had been the norm. In 1950, a future vice admiral, Gerald Miller, was on a carrier group staff operating F9F-2 Panthers in Korea. On one occasion the group staff meant to swap sixty-four Panthers from an outgoing carrier to one just coming into the theater. The weather was bad at airfields ashore, and heavy seas were causing the flight decks to pitch. The staff work and planning did not adequately take into account the limited endurance of the new jet-powered aircraft. Miller's description of what happened next illustrates the consequences of learning to operate jets in a wartime environment:

> We had a lot of these fighters in the air. Then we tried to bring them down and it was a tough job of getting them on board. They were running out of fuel and there was no base on the beach to send them to. We had to get them back on board those two carriers, and we broke up those planes in some numbers.

F9F-2 Panther

Courtesy National Naval Aviation Museum

> It was awful. It was so bad, I can still remember the admiral walking over to the opposite side of the bridge, putting his head down on his hands and shaking. It was so bad he couldn't even get mad. It was a horrible mess. Well, that was all because of the size of the ship, the nature of the airplanes and straight deck operations. We started from debacles of that kind to get something better.
>
> Considering the upheaval in the navy caused by demobilization and the introduction of new technologies, it's amazing that we kept together as much as we did. . . . We worried, but we did proceed with the jet program.[4]

At the same time that naval aviators were attempting to master the new jet aircraft, they were also grappling with two new missions that increased the degree of difficulty even more: night or all-weather operations, and nuclear weapons delivery. In a sense, these two missions were connected, in that it was felt that when the call came, weather or darkness must not be allowed to stand in the way of getting the nuclear weapon to its target. These two missions exerted considerable pressure on aircraft design and on the risks naval aviation was willing to endure to put these capabilities to sea. Coupled with the hazards inherent in jet-powered aviation in those years, they significantly contributed to the loss of aircraft. Gerald O'Rourke, USN (Ret.), describes the environment in Composite Squadron Four (VC-4, based at Naval Air Station Atlantic City, New Jersey), the Navy's East Coast night/all-weather fighter squadron in the early 1950s:

> All naval aviators are routinely exposed to, or involved in, aircraft accidents. That's accepted as almost a hazard of the trade. In carrier work, where dangers abound, accidents tend to be more frequent. In the night carrier operations of those days, accidents were so frequent that they were considered commonplace and unexceptional. Whenever a det [detachment of four to six aircraft sent out on a carrier] departed, the aircraft they flew off were more or less written off. No one expected that all of them would ever come back to Atlantic City. . . . Unfortunately, the same negativism tended to extend to the pilots as well, whose safe return wasn't much better than the aircraft. Between pilots lost, the pilots maimed, and the pilots who decided to throw in their wings, precious few dets ever returned with the same resources they took with them.[5]

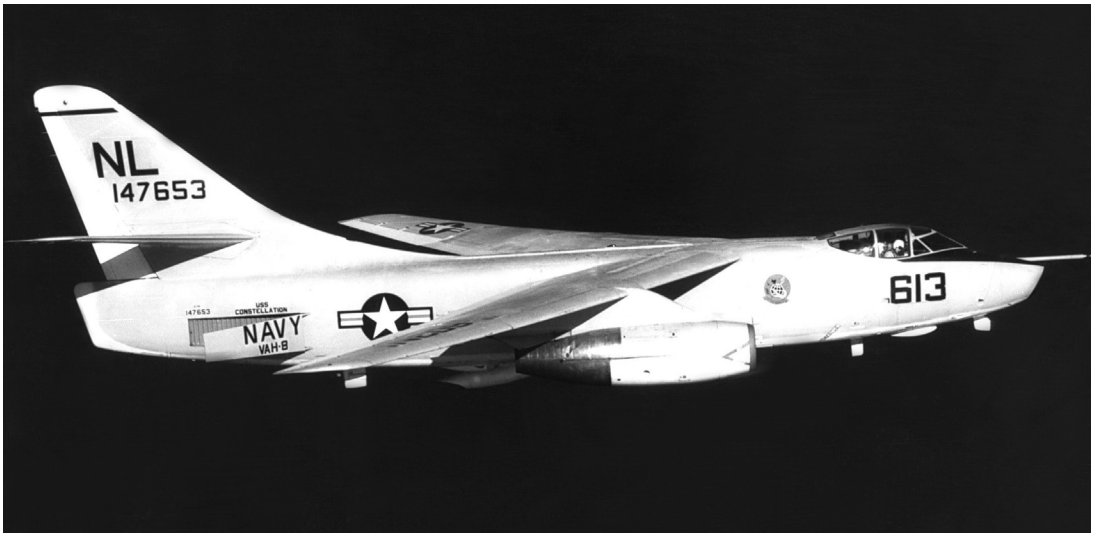
NAVAL AVIATION CULTURE AND THE TRANSITION TO JETS

In order to understand the catastrophic price the Navy paid in its march to operate swept-wing jets from aircraft carriers, we must look at the organizational culture onto which this new technology was grafted. After all, the majority of the mishaps that occurred were due to aircrew errors of some sort, whether precipitated or exacerbated by design problems or the result of gross error, negligence, or irresponsibility not connected with design issues.

Naval aviators always viewed themselves as daredevils. The difficulties of taking off from and landing on ships were unequaled in the land aviation domain, and naval aviators therefore considered themselves exceptionally skilled—and expendable. The accident rate (if not the sheer number of mishaps) in naval aviation from its inception to World War II was hardly less than the awful rates experienced in the early jet era. Naval aviators always regarded themselves as a different breed from their surface-ship brethren, but for all that they shared, and still do, the Navy's culture of independence and self-reliance. The simplicity and relative inexpensiveness of early naval aircraft allowed this culture to thrive; flight instruction was personal, and aviators had few detailed procedures or rules to follow in mastering their aircraft. "Seat of the pants" flying and individuality in technique were the orders of the day. Since piston-engine aircraft all operated essentially in the same way and roughly at the same speeds, especially when landing, and since they rarely flew at night or in bad weather, pilots could transition between aircraft easily and informally. Mr. Richard "Chick" Eldridge, a member of the Naval Safety Center staff for several decades, remembers his Navy flight training in 1943: "To my recollection, there was little emphasis on aviation safety. What safety information was imparted to the fledgling aviator came from the primary instructors. Lessons learned usually came in the form of 'gems of instructor wisdom.' You were simply told to fly certain maneuvers in a specific way or wind up as a statistic."[6]

The first thing to change was the technology. Culture change lagged by more than a decade, and the result was a virtual bloodbath. In addition to the specific challenges of flying jets must be added greatly increased speeds. Things happen much faster in jets, and a different mind-set and discipline are called for to avoid disaster. Pilots who had spent a good deal of time operating at propeller-aircraft speeds tended to have more difficulty adjusting to jet speeds than those who were introduced to jets early. The author observed this during the Navy's transition from the piston-engine S-2 Tracker carrier antisubmarine aircraft to the jet-powered S-3 Viking. The more senior pilots seemed to have the most difficulty, and indeed a number of them either quit, had accidents, or failed to pass flight checks. This was a serious issue as well for the fleet introduction of the A-3 Skywarrior. Initially, in addition to carrier pilots, the Navy brought into the A-3 program senior aviators from the land-based patrol community. A series of accidents and difficulties involving former patrol pilots prompted the commander of the Sixth Fleet to write a letter to the CNO recommending that only carrier-trained pilots be assigned to A-3 squadrons.[7]

In the early years of the jet transition, naval aviation remained wedded to its individualistic culture. Structured programs of training, detailed reference manuals, and disciplined evaluations of pilot performance did not exist in any



A-3 Skywarrior

Courtesy National Naval Aviation Museum

coherent way across naval aviation. But jets, with their higher speeds, challenging handling characteristics, and ever more complex systems, required just that. The horrible accident rates eventually drove the Navy to do something. Meanwhile, the Air Force, which had been suffering an increase in mishaps also, formed a Flight Safety Directorate, with 525 personnel, and undertook to impose discipline on the aviation corps by punishing crews after mishaps when fault and culpability could be assigned. The Navy's first effort at a flight-safety agency was puny by comparison, with only twenty-five personnel. However, in 1953 a war hero, Captain James F. "Jimmy" Flatley, wrote a highly critical and influential report on naval aviation safety that generated organizational and procedural changes that in turn went far to change the culture.[8] Along with them, a more structured program of flight training was introduced, eventually culminating in the establishment of replacement training squadrons that provided intensive and detailed instruction for newly "winged" aviators in the aircraft they would fly in the fleet. These squadrons would also become centers of flight and maintenance evaluation of fleet squadrons based with them. A variety of other measures also served to professionalize and discipline the naval aviation culture, including formal training for squadron safety officers, improved accident investigation techniques, specially trained medical personnel (called "flight surgeons"), the publication of a safety magazine to share stories of accidents and near misses, and top-down leadership that countered the laissez-faire cultural heritage.

However the "ready room" culture was resistant to change. Thus the authors of a 1961 *Naval Aviation News* article felt compelled to say, "Some people view

the idea of everyone in Naval Aviation doing everything 'the one best way' with some misgivings. They fear that general use of standardized procedures, while it may reduce the accident rate, will result in a reduction of a pilot's ability to 'think on his feet' and deal flexibly with emergencies and combat situations. Experience in other fields has proved that fear unfounded."[9] A major element of the resistance to change was the fact that adaptation to the new technology had a value content—that is, it made irrelevant certain skill sets that had been associated with being a "good" aviator. The issue was not so much the difficulty of learning new skills as reluctance to abandon old ones that were associated with professional virtue. The naval aviation culture that had grown up from 1911 to 1947 was intense, parochial, and value-centric. Moreover, likely because of the acrimonious relationship that developed between the two services in the late 1940s, there was a reluctance to view anything the Air Force did as appropriate for naval aviation.

The Navy has always placed considerable responsibility and authority in the hands of the individual officer. An imperative of war at sea, this delegated style of command and control has both enhanced and afflicted U.S. naval aviation. Throughout its history, outstanding decision making by relatively junior officers has made the difference in battle, such as when, during the battle of Midway, Lieutenant Commander Wade McClusky decided, in the air, to take his strike group in the direction a Japanese destroyer was headed and thus found the enemy aircraft carriers. Faced in the 1940s and '50s with new technology that demanded new types of procedural discipline and centralized management, the culture was slow to adapt, and many naval aviators lost their lives as a result.

FINDING THE RIGHT COMBINATION OF INGREDIENTS

The development of aviation technology between the Wright brothers' first flight and 1947 was amazingly fast. In just forty-five years aviation progressed from machines that were hardly more than powered kites to jets that pushed the speed of sound. This rapid development meant that individual models of combat aircraft became obsolete fairly quickly. This had been the case prior to and during World War II, and it was to be the case over the early years of jet transition in the Navy. The initial echelon of straight-wing jets had an operational life span in the fleet of only a few years, although some of them had longer, second lives in the reserves or specialized shore-based uses, such as in training commands. In the late 1940s and the early '50s, as whole squadrons transitioned from propeller airplanes to jets, pilots who had developed habits molded to straight-wing propeller planes that were slower, lighter, and simpler and burned fuel more slowly were put into fast, gas-guzzling jets. It was a lethal combination.

As the centennial of naval aviation approaches, it is interesting to observe that it has been jet powered for over half of its history. The transition was long and brutally expensive in terms of life and aircraft. However, it was, by any measure, a success. Throughout the Cold War and a series of hot wars—Korea, Vietnam, DESERT STORM, and others—naval aviation has been able to provide effective tactical airpower from the sea. Its ability to do this despite a long and difficult process of learning how to operate jet aircraft at sea is a tribute to the brilliance of various aircraft designers, the ingenuity of countless "airdales," the sailors who struggled to keep those complex and touchy machines flying, and the bravery (and perhaps foolhardiness) of the crews who would climb into jets that were hard to fly and lacked reliability and in those aircraft perform missions that took them to the edge of what man and machine could do.

NOTES

This article is adapted from a paper delivered at the U.S. Naval Academy's 2009 Naval History Symposium, held at Annapolis, Maryland, 10–11 September 2009. It will appear in different form in the forthcoming proceedings of that conference, *100 Years of U.S. Navy Air Power.*

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